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Use of modified Nilgiri bark for scavenging copper ions from industrial waste water

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Abstract
Use of Nilgiri tree bark's substract (Eucalyptus globulus) for the removal and recovery of copper ions from industrial waste water is discussed here. The dried and powdered bark is contacted with acidified formaldehyde and the resin product so obtained is found to be highly efficient in removing Cu^{2+} ions from the solutions. The metal ion uptake increases with increasing pH values. It is also observed that more than 99% of Cu^{2+} ions is removed by substrate from solutions instantaneously. By using packed columns of the substrate, the metal ion concentration from waste waters can be reduced to very low levels conforming to the acceptable water quality standards.

Keywords: Nilgiri bark, industrial waste water, Copper ions.

INTRODUCTION

In view of toxicity of heavy metal ions, stringent limits have been imposed by the Public Health Authorities regarding their effluent concentrations. Excessive amount of heavy metal ion like copper can induce toxic effect like liver damage. Several workers described the use of various tree barks like the red wood, hemlock and red oak for selective removal of toxic heavy metals cations from industrial wastes such as mercury and lead battery waste and mine runoff. The metals were possibly bound to the bark substrates by ion exchange with hydrogen, presumably the phenolic groups in tannin compounds.

The author has used the bark of commonly available Indian tree, Nilgiri (Eucalyptus globulus) for the removal and recovery of copper ions from waste waters and the results are reported in the present work.

EXPERIMENT

The Nilgiri bark is dried and finely powdered in an electric grinder. 2gm of the powder were added to a mixture of 20 gm of 0.2 gm of 0.2 N H_2SO_4 and 5 gm of 39% HCHO and the whole mixture was stirred for 6 hours at 50°C and then filtered. The residue was washed with demineralised water till pH of filtrate was 4 to 5 and the same was then dried at 50°C in an electric oven and was powdered. The data below shows the sorption of Cu^{2+} ions on the treated Nilgiri substrate with respect to parameters such as effect of pH, temperature, contact time, anions effect, concentration and effect of light metals ions along with Cu^{2+} ions if present.

RESULT AND DISCUSSION

pH Effect

It was found that the Cu^{2+} ion uptake increases with increasing pH of the solution. The maximum Cu^{2+} ion recovery occurs at pH-8 which is 98.67%.

Temperature Effect

It is observed that the percentage removal of Cu^{2+} ions from the solution on the substrate decreased with increase in temperature. The maximum recovery of Cu^{2+} ions occurs at 30°C.

Contact time Effect

It was found that 55% of the Cu^{2+} ion removal from the solution occurred within 5 minutes, showing a very fast metal ion uptake on the substrate. The Cu^{2+} ions removal from solutions recorded a value of 60% after a contact time of 2 hours and the value remained same even after a contact time of 24 hours.

Anions Effect

It is observed that from copper acetate solution removal of Cu^{2+} was found to be 87%, from copper nitrate solution it is 61%, from copper sulphate solution it is 59% and from copper chloride solution it is 51% .

Light Metal Ions Effect

It was found that upto 1000ppm of the respective light metal ions (like Na^{+}, Mg^{2+}, Ca^{2+} etc.) co-existing with the Cu^{2+} ion in the solution, there is no appreciable change in the sorption of Cu^{2+} ion by the substrate.

Concentration Effect

The effect of initial metal ion concentration on the uptake of Cu^{2+} by the substrate was studied and the results are shown as an isotherm in the Figure 1 and 2. The absolute metal ion removal from the solution increases with increasing initial metal ion concentration although the percentage of metal ion recovery naturally decreased.

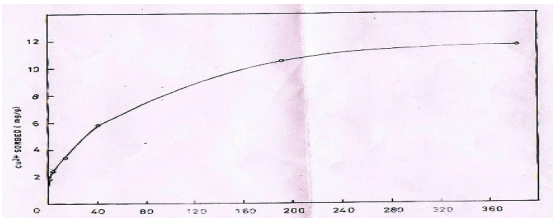

Fig 1. Residual Cu^{2+} In solution (ppm)

Adsorption isotherm: effect of concentration on the uptake of cu^{2+} ions from $CuSO_4$ solution using eucalyptus globulus bark substrate

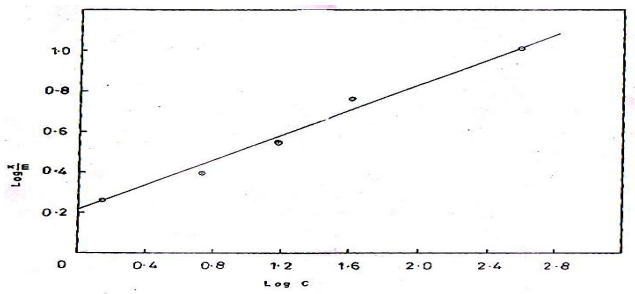

Fig 2. Freundlich adsorption isotherm: Adsorption of cu^{2+} ions from $CuSO_4$ solution using eucalyptus globulus bark substrate

Column Experiment

A continuous process employing a packed column of the Nilgiri bark substrate is expected to be more efficient and economical to operate than the batch experiment. Several column experiments have been conducted and result is as follows:

When the initial concentration of Cu^{2+} ion is 100ppm, the final concentration of 25ppm.

For column experiment 1ltr of Cu^{2+} solutions was passed down the column of 20 mn internal diameter packed with 10gm substrate at the rate of 5ml per minute.

Recovery of the Sorbed Metal Ions

The sorbed heavy metal ions could be leached out from the substarte using dilute HNO_3 . The washed substrate can be reused.

CONCLUSION

The Nilgiri bark substarte seems to be very efficient and economical for removing Cu^{2+} ions from industrial waste waters. By employing adequate column of the substrate the residual Cu^{2+} ion concentration in the effluents can be reduced to a very low level which are within their acceptable discharge limits. The raw materials used for the preparation of the substrate are widely available and inexpensive. Hence Nilgiri bark substrate seems to offer a very cheap and useful product for effective removal and recovery of Cu^{2+} ion from industrial waste water effluents

By using such substrate, it is possible to use waste cellulosic material for preparing a very efficient cation exchanger which is more cheaper than the cation exchanger resins available in the market, which in its turn removes heavy metals cations (toxic and nontoxic) from their respective effluents. These metals ions can be removed and can be reused thereby solving the problems of toxic effects in waste water on living organisms. This also helps to solve the water pollution problem.

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